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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/038,371	01/02/2002	Gerald W. Gibson JR.	47070/MJM/A717	9263

23363 7590 12/17/2002

CHRISTIE, PARKER & HALE, LLP
350 WEST COLORADO BOULEVARD
SUITE 500
PASADENA, CA 91105

EXAMINER

CHU, CHRIS C

ART UNIT PAPER NUMBER

2815

DATE MAILED: 12/17/2002

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/038,371

Applicant(s)

GIBSON ET AL.

Examiner

Chris C. Chu

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 September 2002.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1 - 24 is/are pending in the application.
- 4a) Of the above claim(s) 16 - 24 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1 - 15 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 02 January 2002 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of Group I in Paper No. 7 is acknowledged.

Drawings

2. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: the reference numbers "29" in Fig. 3 and "109" in Fig. 6 are not disclosed in specification of instant invention. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
3. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference characters "109" and "111" in Fig. 6 have both been used to designate a barrier layer film. A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

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4. Applicant is required to submit a proposed drawing correction in reply to this Office action. However, formal correction of the noted defect may be deferred until after the examiner has considered the proposed drawing correction. Failure to timely submit the proposed drawing correction will result in the abandonment of the application.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

The changes made to 35 U.S.C. 102(e) by the American Inventors Protection Act of 1999 (AIPA) do not apply to the examination of this application as the application being examined was not (1) filed on or after November 29, 2000, or (2) voluntarily published under 35 U.S.C. 122(b). Therefore, this application is examined under 35 U.S.C. 102(e) prior to the amendment by the AIPA (pre-AIPA 35 U.S.C. 102(e)).

6. Claims 1, 3 ~ 5, 9 and 10 are rejected under 35 U.S.C. 102(e) as being anticipated by Chooi et al.

Regarding claim 1, Chooi et al. discloses in Fig. 16, column 5, line 51, and column 6, lines 6 ~ 17 a semiconductor product comprising a barrier layer (24 and 34) disposed between a

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copper-containing structure (20 and 12) and a low-k dielectric film (50), said barrier layer (24 and 34) comprising a composite film structure including a nitrogen-containing, substantially oxygen-free first film (24) forming a boundary with said copper-containing structure and an oxygen-containing, substantially nitrogen-free second film (34) forming a boundary with said low-k dielectric film.

Regarding claim 3, Chooi et al. discloses in Fig. 16, column 5, line 51, and column 6, lines 6 ~ 17 first film comprising silicon nitride and said second film comprising silicon dioxide.

Regarding claim 4, Chooi et al. discloses in Fig. 16 said copper-containing structure comprising a surface including a copper wire (20) formed within an insulating material (12).

Regarding claim 5, Chooi et al. discloses in Fig. 16 said barrier layer (24 and 34) being formed on said copper-containing structure and said low-k dielectric film is formed on said barrier layer.

Regarding claim 9, Chooi et al. discloses in Fig. 16 and column 6, lines 12 ~ 17 said low-k dielectric film having a dielectric constant less than 3.5.

Regarding claim 10, Chooi et al. discloses in Fig. 16, column 5, line 51, and column 6, lines 6 ~ 17 a semiconductor product comprising a barrier layer (24 and 34) disposed between a readily-oxidizable conductive material (20) and a low-k dielectric film (50), said barrier layer comprising a composite film structure including a nitrogen-containing, substantially oxygen-free first film (24) forming a boundary with said conductive material and an oxygen-containing, substantially nitrogen-free second film (34) forming a boundary with said low-k dielectric film.

Claim Rejections - 35 USC § 103

7. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

8. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. in view of Kariya et al.

Regarding claim 2, Chooi et al. discloses the claimed invention except for said first film comprising nitrogen-doped silicon carbide, and said second film comprising oxygen-doped silicon carbide. However, Kariya et al. discloses in column 13, line 59 ~ column 14, line 2 a first film (the base material of the doped layer) comprising nitrogen-doped silicon carbide, and said second film (the doped layer on the light incident side) comprising oxygen-doped silicon carbide. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to modify Chooi et al. by using the nitrogen-doped silicon carbide for the first film and the oxygen-doped silicon carbide for the second film as taught by Kariya et al. The ordinary artisan would have been motivated to modify Chooi et al. in the manner described above for at least the purpose of decreasing light absorption (column 13, line 66).

9. Claims 6, 7, 11, 12, 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. in view of Bjorkman et al.

Regarding claim 6, Chooi et al. discloses in Fig. 16 an insulating film (48) formed over said low-k dielectric film (50), a further low-k dielectric film (68) formed over said insulating film and an insulating hardmask (70) formed over said further lower-k dielectric film.

Chooi et al. does not disclose an oxygen-doped silicon carbide for an insulating film and an insulating hardmask. However, Bjorkman et al. discloses in column 3, lines 24 ~ 27 and column 6, lines 40 and 41 an oxygen-doped silicon carbide for an insulating film and an insulating hardmask. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to modify Chooi et al. by using the oxygen-doped silicon carbide as taught by Bjorkman et al. The ordinary artisan would have been motivated to modify Chooi et al. in the manner described above for at least the purpose of providing a pattern that is transferred to the underlying layers (column 6, line 43 and 44).

Regarding claim 7, Chooi et al. discloses in Fig. 16 said semiconductor product includes a two-tiered opening (the place of 72) extending down from a top surface of said oxygen-doped silicon carbide hardmask, said two-tiered opening including a wider upper portion extending through said oxygen-doped silicon carbide hardmask, said further low-k dielectric film, and said oxygen-doped silicon carbide film, and a lower, narrower portion extending through said low-k dielectric film, said second film, and said first film.

Regarding claim 11, Chooi et al. discloses in Fig. 16, column 5, line 51, and column 6, lines 6 ~ 17 a semiconductor product comprising a film stack including:

- a lower low-k dielectric layer (50);
- an etch-stop layer (48) formed over said low-k dielectric layer;
- an upper low-k dielectric layer (68) formed over said etch-stop layer; and

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- a hardmask layer (70) formed over said upper low-k dielectric layer.

Chooi et al. does not disclose an oxygen-doped silicon carbide for an etch-stop layer and a hardmask layer. However, Bjorkman et al. discloses in column 3, lines 24 ~ 27 and column 6, lines 40 and 41 an oxygen-doped silicon carbide for an insulating film and an insulating hardmask. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to modify Chooi et al. by using the oxygen-doped silicon carbide as taught by Bjorkman et al. The ordinary artisan would have been motivated to modify Chooi et al. in the manner described above for at least the purpose of providing a pattern that is transferred to the underlying layers (column 6, line 43 and 44).

Regarding claim 12, Chooi et al. discloses in Fig. 16 said film stack includes a two-tiered opening (the place of 72) formed therein, said said two-tiered opening including a wider upper portion disposed over a narrower lower portion, said narrower lower portion extending through said lower low-k dielectric layer, said wider upper portion extending through said etch-stop layer, said upper low-k dielectric layer and said hardmask layer, and said two-tiered opening filled with a conductive material.

Regarding claim 14, Chooi et al. discloses in Fig. 16 and column 5, line 51 said further conductive material (20) comprising copper.

Regarding claim 15, Chooi et al. discloses in Fig. 16, column 5, line 51, and column 6, lines 6 ~ 17 a semiconductor product comprising a film stack including:

- a copper-containing surface (20 and 12);
- a nitrogen-containing first barrier layer (24) disposed over said copper-containing surface;

- an oxygen-doped, substantially nitrogen-free second barrier layer (34) disposed over said first barrier layer;
- a first low-k dielectric film (50) disposed over said second barrier layer;
- an etch-stop layer (48) disposed over said first low-k dielectric film;
- a second low-k dielectric film (68) disposed over said etch-stop layer; and
- a hardmask film (70) disposed over said second low-k dielectric film.

Chooi et al. does not disclose an oxygen-doped silicon carbide for an etch-stop layer and a hardmask layer. However, Bjorkman et al. discloses in column 3, lines 24 ~ 27 and column 6, lines 40 and 41 an oxygen-doped silicon carbide for an insulating film and an insulating hardmask. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to modify Chooi et al. by using the oxygen-doped silicon carbide as taught by Bjorkman et al. The ordinary artisan would have been motivated to modify Chooi et al. in the manner described above for at least the purpose of providing a pattern that is transferred to the underlying layers (column 6, line 43 and 44).

10. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. in view of Grill et al.

Regarding claim 8, Chooi et al. discloses the claimed invention except for said low-k dielectric film being formed of SiOC-H. However, Grill et al. discloses in column 11, lines 19 ~ 23 a low-k dielectric film being formed of SiOC-H. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to modify Chooi et al. by using the SiOC-H for the low-k dielectric film as taught by Grill et al. The ordinary artisan would have

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been motivated to modify Chooi et al. in the manner described above for at least the purpose of providing amorphous hydrogenated silicon (column 11, line 22).

11. Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over Chooi et al. and Bjorkman et al. as applied to claim 11 above, and further in view of Kariya et al.

Regarding claim 13, Chooi et al., as modified, discloses in Fig. 16 a composite film structure (24 and 34) formed beneath said lower low-k dielectric layer (50) and including a first doped film (24) formed beneath a second doped film (34), and wherein said narrower lower portion further extends through said composite film structure and said two-tiered opening (the place of 72) extends to a bottom surface formed of a further conductive material (20).

Chooi et al. does not disclose using nitrogen-doped silicon carbide in the first doped film and oxygen-doped silicon carbide in the second doped film. However, Kariya et al. discloses in column 13, line 59 ~ column 14, line 2 using nitrogen-doped silicon carbide in the first doped film and oxygen-doped silicon carbide in the second doped film. Thus, it would have been obvious to one of ordinary skill in the art at the time when the invention was made to further modify Chooi et al. by using the nitrogen-doped silicon carbide and the oxygen-doped silicon carbide as taught by Kariya et al. The ordinary artisan would have been motivated to further modify Chooi et al. in the manner described above for at least the purpose of decreasing light absorption (column 13, line 66).

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Lee, Seirii et al. and Jang et al. disclose a dual damascene structure.

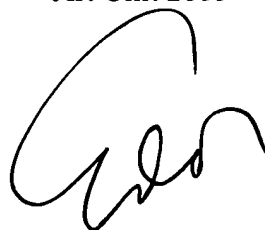
Any inquiry concerning this communication or earlier communications from the examiner should be directed to Chris C. Chu whose telephone number is (703) 305-6194. The examiner can normally be reached on M-F (10:30 - 7:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Eddie C. Lee can be reached on (703) 308-1690. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 308-7382 for regular communications and (703) 308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

Chris C. Chu
Examiner
Art Unit 2815

c.c.
December 12, 2002



EDDIE LEE
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800